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NANOSIMS MEASUREMENTS OF SOLAR WIND Mg, Fe, AND Cr FLUENCES

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Introduction: The chemical composition of the Sun provides the reference standard for a wide variety of astronomical, cosmochemical, and geochemical studies. To better determine the solar composition, the Genesis spacecraft collected solar wind at the L1 point in the space for 27 months prior to returning samples to Earth in September 2004. Prior ion probe analyses of Genesis samples have found discrepant results for the Mg and Fe solar wind fluences from different collector materials [1]. We report measurements of Mg, Fe, and Cr depth profiles in Genesis diamond-like C sample 60062 using the Carnegie Institution Cameca NanoSIMS 50L ion microprobe. Our results for Mg and Fe are similar to previous analyses of the same sample using different instruments.

Experimental: The very high primary beam density of the NanoSIMS allows smaller craters to be analyzed compared to the IMS 6f and IMS 1270 ion probes used for previous work. For this study, a 4 nA −16kV O^- primary beam of about 2 µm in diameter was rastered at 25×25 µm^2 on the sample surface with positive secondary ions extracted from the central 25% of the rastered area. Masses ^{12}C, ^{24}Mg, ^{25}Mg, ^{52}Cr, ^{54}Fe, and ^{56}Fe were measured simultaneously to a depth of about 500 nm from the surface. ^{25}Mg and ^{54}Fe implanted standards were measured before, after, and in between sample analyses to quantify relative fluences. Since no Cr implant standard was available at the time of our analyses, we used the relative sensitivity factors in diamond reported by [2] to quantify Cr fluences. We analyzed 10 craters with one showing abnormally low ^{12}C count rates and thus excluded. One crater showed significant surface contamination of Fe and no Fe data could be deduced.

Results: We found an Mg fluence of $4.33 \pm 0.26 \times 10^{12}$ cm^{-2} and an Fe fluence of $2.39 \pm 0.15 \times 10^{12}$ cm^{-2} for sample 60062. These are in good agreement with previous measurement of the same samples by IMS 6f [1]. As seen before, the fluences derived from diamond-like C are higher than those from Si collectors; an explanation for this discrepancy is still lacking but the results from Si are preferred. Based on three ^{52}Cr depth profiles, we estimated a Cr fluence of 2.2×10^{11} cm^{-2}. This value is about seven times higher than that found in Si by [1]. However, surface contamination for this sample is apparently a contributing factor. The $^{25}Mg/^{24}Mg$ ratios derived from the profiles are slightly elevated (by up to ~10%) compared to the terrestrial value, probably indicating a large contribution of MgH to the ^{25}Mg signal in the flight sample. Further measurements at higher mass resolution will provide more accurate isotopic abundances. Analyses of additional elements and collector materials also will be conducted to get more accurate data of the solar wind composition and to understand differences between different collector materials.

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SEM-PETROGRAPHY OF OSTENSIBLY ANCIENT NORTH RAY CRATER LUNAR IMPACT-MELT ROCKS

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Lunar polymict impactite samples have yielded ages that strongly cluster near 3.9 Ga, especially for impact-melt breccias. This curiously unimodal age spectrum clearly indicates that the rate of cratering (i.e., collisions between the Moon and asteroids and comets) was vastly higher ~3.9 billion years ago than it has been over the last 85% of solar system history. The bombardment history before 3.9 Ga, however, has been controversial. The relative scarcity of ages >3.9 Ga has led many to infer a spike in the global lunar cratering rate at ~3.9 Ga, i.e., the lunar "cataclysm" hypothesis [1]. Do the clustered ~3.9 Ga ages reflect a bump or inflection on a basically monotonic decline in the late-accretionary impact rate, or a large-factor and global spike?

The age of the Nectaris basin is key. On photogeologic-stratigraphic grounds, Nectaris is clearly older than Imbrium and Serenitatis; and two-thirds of the Moon's still-recognizable basins appear even older than Nectaris [2]. Impact-melt breccias (IMBs) of Nectaris origin are presumably present among the Apollo 16 samples. Ar ages for Ap-16 IMBs largely cluster from 3.87–3.92 Ga, and 3.90–3.92 Ga is often assumed to be the age of Nectaris (e.g., [1, 2]). However, there are reasons to doubt the proposed linkage between these common Ap-16 IMBs and Nectaris. Compared to the Ap-16 site, the Nectaris region is greatly depleted in incompatible elements; the ~3.9 Ga age IMBs are incompatible-rich [3]. The typical siderophile-element pattern of the ~3.9 Ga age IMBs features the same distinctively high Au/Ir typical of Ap-14, Ap-15, and Ap-17 IMBs, albeit the regoliths at these sites contain very minor debris from Nectaris in comparison to Imbrium and Serenitatis (to accept the cataclysm hypothesis, must we also assume a uniform source of impactor asteroids?).

A more direct challenge to the proposed ~3.9 Ga age for Nectaris stems from ~15 Ar ages reported for small rocks from the two Ap-16 North Ray crater sampling stations. We have used SEM and *e*-probe techniques to better constrain the impact-melting, brecciation, and thermal evolution of 12 such rocklets with reported age (after correction to modern decay constants) ≥4.03 Ga. Previous petrographic descriptions of these samples have ranged from brief [4] to both brief and nonspecific [5, 6], and none have utilized SEM. Some of these pre-4.03 Ga North Ray crater rocks are plausibly interpreted as true pre-"cataclysm" impact products; most are (at least individually) dubious. As an example of the utility of SEM, we readily noted that most of the "feldspathic fragment-laden" IMBs [6] contain reverse-zoned plagioclase relicts, with very sharp boundaries between the Ab-rich core and the rim. The scale of these rims is consistent within each IMB, and affords a constraint on the degree to which CaAl-NaSi interdiffusion (vastly slower than Ar diffusion) managed to equilibrate the relict feldspars with the melt-derived groundmass.

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